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In the Eye of the Storm: Houston after Hurricane Harvey

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“In the Eye of the Storm: Houston after Hurricane Harvey”

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Acknowledgements

This thesis is dedicated to those affected by Harvey. You are not alone in this journey. In writing this thesis, I was forced to relive the fear felt throughout the Texas Gulf Coast on that warm mid-August night. I was also reminded of the heroism demonstrated by Houstonians, who offered their own resources amidst the worst flood in Houston's history. This thesis is also for all of you.

I would like to extend my gratitude to my Claremont professors, my friends, and my family back in Houston, TX. The guidance and knowledge gained from my mentors has been invaluable, and my family's support has kept me moving forward.

I would like to thank Char Miller for his direction throughout this process and for opening my eyes to the injustices in the world.

I would like to give a warm thank you to Nina Karnovsky for always making me feel so welcome at Pomona and for opening her lab for me to write and reflect in.

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INTRODUCTION

"We had to watch the weather to keep us up-to-date.
Harvey was slowly getting closer. All we could do was wait.
The rain finally started falling. Huge waves began to crash.
The coast of Texas was hit first, and then we were in its path."
- Landon Hayek, "They Called Him Harvey"

The Aftermath

While I read Landon Hayek's poetry book on Hurricane Harvey, I was reminded of the traumas that were experienced across not only the city of Houston but along the entire Texas Gulf Coast in the summer of 2017. Though he was only nine years old when he wrote "They Called Him Harvey," Landon's poem accurately portrays the emotions felt by millions before Harvey hit. His illustrated book maintains a cheerful tone, and the proceeds from the book benefit those affected by Hurricane Harvey. Still, sadness fell over me while I read, and my eyes watered.

The following summer was dominated by a feeling of angst. I was back home in Houston and was free from the responsibilities of college, but I could not overcome the fact that Hurricane Harvey was the third "500-year" flood in a span of three years. The National Weather Service assured us that "there [was] a 0.2 percent chance of having a flood of that magnitude [occur]" in any given year, yet we were seeing these disasters occur annually.[1] To some extent, we could not trust the claims and suggestions made by experts and leaders because they had failed us before (i.e. the catastrophic failure to evacuate Houston when Hurricane Rita hit and the

[1] US Department of Commerce, NOAA. "Flooding FAQ." Accessed September 29, 2018. https://www.weather.gov/lot/floodingfaq.

failure to evacuate Houston when Harvey hit).[2] Taking matters into our own hands, my family and I made a habit of carefully traversing the streets of Houston following a major flood. We were told by police to avoid walking on the streets since flooded potholes and sewer drains were invisible under the murky water. More drastic still were the unexpected changes in elevation throughout the city's unorganized sprawl, which easily swept cars away in deeper waters. Even truck drivers were found perched on top of their enormous eighteen-wheelers as they waited for a boat or helicopter to save them from the flooded highways (Figure 1). Stories like these became commonplace. The Federal Emergency Management Agency (FEMA) reported over 6,500 highway water rescues and close to 122,331 people were rescued by local, state and federal first responders. Clearly, Houston and its inhabitants were dangerously unprepared for the "more than 19 trillion gallons of rainwater" that would inundate one-third of the city.[3]

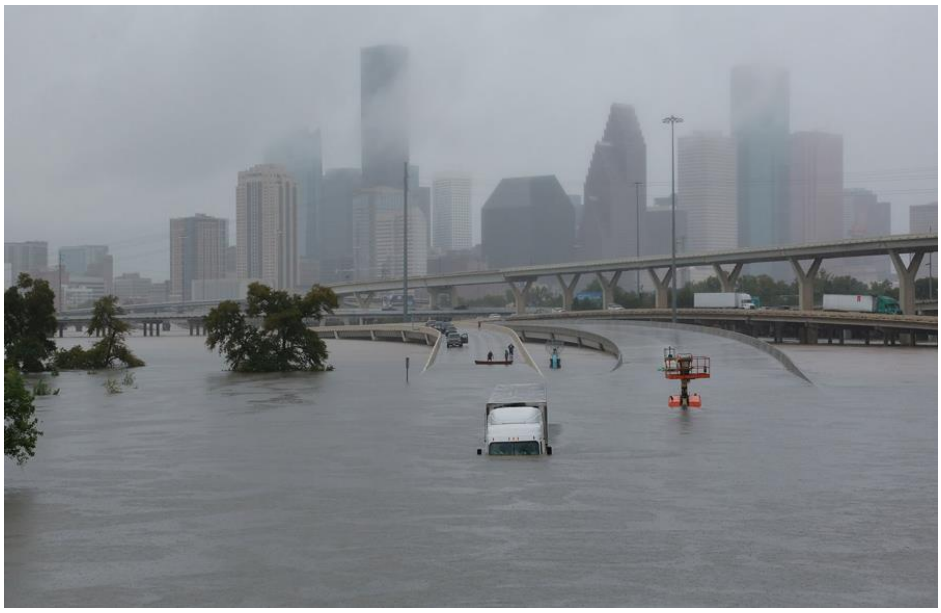

FIGURE 1: INTERSTATE HIGHWAY 45 APPEARS SUBMERGED BY OVER 34 INCHES OF RAIN BROUGHT FORTH BY HURRICANE HARVEY ON AUGUST 27, 2017. RICHARD CARSON / REUTERS

[2]Levin, Matt, "How Hurricane Rita Anxiety Led to the Worst Gridlock in Houston History - Houston Chronicle," Houston Chronicle, August 25, 2017, https://www.chron.com/news/houston-texas/houston/article/Hurricane-Rita-anxiety-leads-to-hellish-fatal-6521994.php.

[3] FEMA, "Historic Disaster Response to Hurricane Harvey in Texas | FEMA.Gov," September 22, 2017, https://www.fema.gov/news-release/2017/09/22/historic-disaster-response-hurricane-harvey-texas.

Hurricane Harvey undoubtedly scarred me, but the intensity of the experience is not what led me to write this thesis. For your average Houstonian, rain and occasional flooding is part of living in the Bayou City, especially during the wet summer seasons. There is no way around the fact that Houston's humid subtropical climate attracts, on average, 50 inches of rain annually.[4] The very same amount of rain that bombarded Houston over the span of just three days during Harvey. Still, I decided to return home in the summer of 2018. My experiences that summer would ultimately lay the foundation for this thesis, for the Houston that welcomed me that summer donned the scars of the previous year. Empty plots of land were a grim reminder of the families that lost their homes, and the sudden spike in new construction and housing units hinted at a city desperately trying to rebuild. As homeowners throughout the region rebuilt their properties, displaced people also sought to rebuild their lives. Some moved away after deciding that the uncertainties of living in a place like Houston are too great to risk, but they were the minority. Because of Hurricane Harvey, over 42,000 Texans were housed in temporary shelters after nearly "80,000 homes [were flooded by] at least 18 inches of floodwater." Of those homes, 23,000 were inundated with more than 5 feet of floodwater.[5] Fortunately, FEMA and flood insurance companies allowed a portion of the affected population to return to their damp and damaged homes after conducting preliminary quality assessments. Some people have not experienced that luxury, and now over 500 individuals live in tents under polluted highways.[6]

Homelessness in Houston, like in any other American metropolis, has always been present. I have had personal encounters with homeless individuals in my neighborhood since I

[4] rss Weather, "Climate in Houston, Texas," accessed November 16, 2018, http://www.rssweather.com/climate/Texas/Houston/.
[5] FEMA, "Historic Disaster Response to Hurricane Harvey in Texas"
[6] The Coalition for the Homeless, "Local Data and Research | Coalition," May 2018, http://www.homelesshouston.org/local-data-and-research/.

was young, and I helped lead my school's chapter of Habitat for Humanity. Still, this post-Harvey wave of homelessness felt different. A simple explanation for this increase would be that homes were damaged beyond repair, forcing those without any form of savings or aid to take their chances on the streets. This explanation is unsatisfactory and problematic because it diminishes the fault held by the institutions and systems put in place to protect us. The fact that lower-class and minority groups were disproportionately affected by Hurricane Harvey remains a strategically well-hidden reality, but this thesis aims to bring these realities to light. Through an exploration of Houston's history as the energy capital of the U.S. and once one of the harshest Jim Crow cities in the country, I unravel the links between climate change, hurricanes, unequal housing practices, and homelessness. I argue that hurricanes have a disproportionately larger impact on minority groups, especially the lower class, and that their effects are largely rooted in racial inequalities and class divides. Only by recognizing these dynamics can we ever hope to rebuild and move forward, and as we have seen, little stands in the way of us and the next historic flood.

Houston's Flood History

Increasing floods over the past decade are worthy of attention, but these are not isolated events or novel threats. Houston's general disregard of urbanization and development, which plays a role in the city's inability to handle heavy rainfall, has been a key feature of its history. In fact, floods, storms and the subtropical humid climate were actors in how Houston would initially develop. Early settlers and travelers showed a general distaste for the climate and aesthetic of the region. Frederick Law Olmsted, a popular American landscape architect who traveled through Houston in the 1850s, boldly remarked that Houston "is not a spot in which I

should prefer to come to light, burn, and expire; in fact, if the nether region…be a boggy country, the Avernal entrance might, I should think, with good possibilities, be looked for in this region."[7] Born and raised in Houston, I can attest to the accuracy of Olmsted's claims--though the introduction of air-conditioning has surely helped.

Prior to the rise of oil in the late-1800s as the dominant energy source, Houston and the Gulf Coast region were not promising locations for a thriving city. Heavy rainfall often flooded entire marshlands and made areas near regional rivers, streams, and bayous impassable. Furthermore, threats of hurricanes in the region "loomed for six months a year, from June to November, and the same months brought oppressive, debilitating heat and humidity." For these reasons, Houston would remain sparsely populated until the turn of the 20th century. Until then, Houston would be an "island of urban opportunity in a sea of rural poverty."[8] Cotton plantations along the Brazos River would uphold the region's economy until the 1900s, which of course meant a prevalence of slavery, peonage, and racial segregation. Clearly unfit for human settlement, Houston's climate brought forth yellow fever and malaria epidemics by providing ideal conditions for mosquito vectors to procreate. Environmental historians, like J.R. McNeill, often link human-environment relationships using unexpected actors like disease, natural disasters, geography, specific plant and animal species, etc.[9] Employing this framework, I argue that the environment plays a prominent role in shaping human experience, but humans themselves interact with each other and the environment in ways that perpetuate or exacerbate disasters, such as hurricanes and wildfires.

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[7] Olmsted, Frederick L., A Journey through Texas, or, a Saddle Trip on the Southwestern Frontier (New York: Dix, Edwards, 1857), 36

[8] Melosi, Martin V. and Pratt, Joseph, *Energy Metropolis: An Environmental History of Houston and the Gulf Coast*, History of the Urban Environment (Pittsburgh, Pennsylvania: University of Pittsburgh Press, 2007). 21.

[9] McNeill, John R., *Mosquito Empires : Ecology and War in the Greater Caribbean, 1620-1914*, New Approaches to the Americas (New York: Cambridge University Press, 2010),

For Houstonians, the promise of prosperity through the development of the land was far more important than its effects on the environment around them. Houston was notorious for its unwelcoming terrain, yet early settlers still decided to further alter the region. Relying on cotton as a cash crop commodity, Houston was eager to connect its cotton production with markets in the northeast. To achieve this, the city government and commercial interests designated the widening and deepening of existing bayous across the eastern part of the city to establish the Houston Ship Channel. This same ship channel today handles more than 80 million tons of shipping annually. [10] The economic gain associated with the ship channel, urbanization, and population growth propelled the city forward while altering the region's watershed in unprecedented ways. What once was a city of slightly over 2,000 people would become an energy hub of over 80,000 in just two decades. As energy use increased throughout the 1900s, so did Houston's population. In a relative blink of an eye, over 2.3 million people would end up in the fourth largest city in America.[11]

Catastrophic floods have plagued the Texas coast since the earliest recorded settlements, but their frequency, intensity, and impact have increased due to climate change and rapid urbanization. This is worrying because city officials have been slow in taking note of flooding. The earliest measures taken against deluge were in 1937, when the Harris County Flood Control District (HCFCD) was established. [12] Up until the late '90s, HCFCD was successful in keeping the city's many bayous from inundating Downtown Houston with the help of the Addicks and Barker reservoirs (Fig. 2). Houstonians and officials alike took little notice of flooding events

[10] Britannica, "Houston | Geography, History, & Points of Interest | Britannica.Com," September 20, 2018, https://www.britannica.com/place/Houston.
[11] Texas State Historical Association, "Texas Almanac: City Population History from 1850-2000," 2018.
[12] Thompson, Daphne. "Houston's History of Floods." A Brief History of Weather Radar. August 30, 2017. Accessed October 03, 2018. https://blog.weatherops.com/houstons-history-of-floods.

because they were generally mild. That changed in the summer of 2001, when Hurricane Allison's rains and winds ripped through the city, killing 23 people and damaging 70,000 homes and more than 95,000 vehicles.[13] Still, few measures had been taken against flooding other than rebuilding structures that had been damaged by water. This is evident in the amount of money that has been allocated towards hurricane relief and mitigation in the past. Hurricanes Rita and Ike cost Houston less than $20 billion total where Harvey's costs have amounted to over $70 billion plus over $30 billion for proposed projects throughout the city. This is why I feel that Hurricane Harvey is different.

FEMA reported that over 300,000 houses were affected by Harvey's 27 trillion gallons of rain, and total losses across the region exceed $75 billion. [14] Surely a lot can be said about the traumas experienced by those in the path of the hurricane, but an undeniable fact remains: not everyone continues to be haunted by what Harvey did to the city. As I have highlighted, poor and minority groups were and continue to be disproportionally affected by the damages caused by Hurricane Harvey. They are the ones that continue to camp out in crowded underpasses, and they are the ones that are most exposed to the injustices of climate change.

To summarize a few key points, I would like to point to an idea introduced by Brian Black in his book, *Petrolia: The Landscape of America's First Oil Boom*. He states that the rise of the oil industry in Houston marked the beginning of a "culture of massive disturbance" across the country; ultimately, these "massive [disturbances]" would render the region much more susceptible to the effects of climate change, more specifically, hurricanes and floods.[15] Several factors have exacerbated the dangers associated with hurricanes. I argue that, when discussing

[13] Thompson, Daphne. "Houston's History of Floods."
[14] FEMA, "Historic Disaster Response to Hurricane Harvey in Texas".
[15] Black, Brian, *Petrolia : The Landscape of America's First Oil Boom*, 1 online resource (xii, 235 pages) : illustrations, maps. vols., Creating the North American Landscape (Baltimore: Johns Hopkins University Press, 2000),

the effects of natural disasters on communities, social and power structures should be at the forefront of the conversation because these dynamics have shaped and continue to shape the relationships between humans, their environment, and disasters. This thesis aims to unravel the role of society in the ways hurricanes impact humans. Again, I quote historian J. R. McNeill when he states that "humankind and nature make their own history together, but neither can make it as they please."[16] With this in mind, I highlight the development of Houston, TX in relation to minority communities and floodplains. My aspiration with this approach is to highlight the relationships between the areas around Houston that are most susceptible to flooding and their demographics.

I employ an interdisciplinary approach throughout this thesis to convince the reader that human nature and society are central to discussions of disasters and climate change. Chapter 1 introduces the ecology and behavior of hurricanes, from the propagation of atmospheric waves over the continent of Africa to the conditions that allow this initial wave to become a full-fledged tropical cyclone. By listing the conditions necessary for a hurricane to form, I demonstrate how the overarching effects of anthropogenic climate change can increase the severity and frequency of hurricanes around the globe. Chapter 2 dives into the distribution of black and poor populations across Houston. This chapter aims to introduce the systematic and institutional powers responsible for the layout of the city, specifically highlighting Houston's history as one of the most segregated Jim Crow cities in history. Topics in chapter 2 include unequal housing practices, instances of environmental racism, and the precursors leading to modern day Houston. Chapter 3 will explore Hurricane Harvey's impact on the local homeless population. Furthermore, this chapter highlights the inequalities and faults associated with the aid provided

[16] McNeill, John R. *Mosquito Empires: 6*

by federal and state agencies by pointing out class-divides along who receives aid to rebuild after a disaster. Finally, chapter 4 directs us to modern-day Houston and allows us to look towards the future of the Bayou City. Local, state, and federal project proposals are described, compared, and critiqued in this chapter.

My goal in writing this thesis is to point out the inherent inequalities associated with hurricanes, and to a larger extent climate change. I aim to remind the reader that nature is deeply interwoven into the fabric of human society, and though it may be that we have little control over the immediate effects of natural disasters, we do have complete control over how we respond to these challenges. In this way, Hurricane Harvey identified every last chink in our armor. Now, if we fail to learn from our past mistakes, nobody else is to blame but ourselves.

CHAPTER 1

"That so many of us are here today is a recognition that the threat from climate change is serious, it is urgent, and it is growing. Our generation's response to this challenge will be judged by history…No nation, however large or small, wealthy or poor, can escape the impact of climate change. Rising sea levels threaten every coastline. More powerful storms and floods threaten every continent."
-Barack Obama, UN Climate Change Summit (2009)

Climate Change is the Culprit

With urgency, former U.S. President Barack Obama relayed his concerns about climate change to representatives of over 90 nations gathered at the 2009 United Nations Climate Change Summit. Mr. Obama's words were a chilling reminder that climate change is among us. Echoing the former president's concerns, reputable scientific studies around the globe have pointed towards increases in atmospheric carbon from humans altering land-use patterns and burning fossil fuels. The Intergovernmental Panel on Climate Change released a report towards the end of 2018 stating that humans only have until the year 2030 to curb climate change.[17] If humans decrease carbon emissions significantly, then the IPCC suggests that "our world will suffer fewer negative impacts on intensity and frequency of extreme events." In the most general sense, climate change, in particular global warming, is causing a range of environmental disasters, such as drought, sea-level rise, species extinction, and in our case, severe floods and hurricanes. Even if one were to argue that these trends are not linked to climate change, the increasing quantity and intensity of hurricanes across the globe every year is enough to warrant

[17] Intergovernmental Panel on Climate Change *Summary for Policymakers of IPCC Special Report on Global Warming of 1.5ºC Approved by Governments.*Report. October 8, 2018. Accessed October 20, 2018. https://www.ipcc.ch/pdf/session48/pr_181008_P48_spm_en.pdf.

fear. This chapter links climate change to hurricanes using nonrenewable energy as the bridge between them. By framing climate change around energy consumption, I pinpoint how hurricanes have increased in frequency and intensity in response to human activities.

What is a Hurricane?

Hurricanes are defined as "rotating, organized systems of clouds and thunderstorms that originate over tropical or subtropical waters and have closed, low-level circulation"- hence their formal name, tropical cyclones. Typically, storms, tropical depressions, tropical storms, and hurricanes are differentiated primarily by their wind speed and wind patterns. Simply put, a common storm graduates into a tropical storm when maximum wind speeds reach 39 mph, and once a tropical storm's maximum wind speeds reach 74 mph or higher, then the storm is classified a hurricane.[18]

Once a storm becomes a hurricane, life-threatening injuries and damage to infrastructure become more apparent. Therefore, a classification system was developed to discriminate between hurricanes of different intensities. This classification system is called the Saffir-Simpson scale, and it was developed in 1971 by civil engineer Herbert Saffir and meteorologist Robert Simpson after concluding that reliable ways to categorize and describe the damage caused by hurricanes were lacking in depth.[19] Table 1 lists the different wind speeds associated with the different Saffir-Simpson scale categories as well as the type of damage expected from each category. Hurricane Harvey was a category 4 hurricane, but it brought with it a level of

[18] National Oceanic and Atmospheric Administration US Department of Commerce, "What Is the Difference between a Hurricane and a Typhoon?," accessed November 17, 2018, https://oceanservice.noaa.gov/facts/cyclone.html.
[19] Lacovelli, Debi, "The Saffir/Simpson Hurricane Scale: An Interview with Dr. Robert Simpson," accessed November 17, 2018, https://novalynx.com/store/pc/Simpson-Interview-d53.htm.

damage no one could have ever anticipated. Historically, hurricanes are most common in this region of the world between the months of June and November. This window of time is officially called a region's Hurricane Season.[20] Hurricane researchers include members of NASA, the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service (NWS). Aircrafts, buoys, and satellites are used by these groups to determine wind speeds, wind patterns, and ocean and atmospheric temperatures during a hurricane. When combined, the data gathered by these tools allow experts to classify and categorize hurricanes.[21]

[20] NOAA, "What Is the Difference between a Hurricane and a Typhoon?"
[21] Whetzel, Joan, "Tools Used to Measure Hurricanes | Sciencing," March 13, 2018, https://sciencing.com/tools-used-measure-hurricanes-6862094.html.

TABLE 1: HURRICANE CATEGORIES AS DESCRIBED BY THE SAFFIR-SIMPSON SCALE / NATIONAL HURRICANE CENTER

Category	Sustained Winds (mph)	Types of Damage
Tropical Depression	≤ 38	Light flooding and potential power outages
Tropical Storm	39-73	Higher potential for flooding, power outages more common, and light infrastructure damage
1	74-95	Roof and shingle damage, large branches will snap, and extensive damage to power lines is likely
2	96-110	Major roof and home siding damage, uprooted trees will block roads, and power loss is expected to last from days to weeks
3	111-129	Removal of roof decking, blocked roads due to snapped trees, electricity and water will be unavailable for several days or weeks
4	130-156	Major damage or loss of roof and walls, most trees and poles will be downed, power outage likely to last many weeks and area may be uninhabitable
5	157 ≤	Framed homes destroyed, total roof and wall failure, power outages, and area will be uninhabitable for weeks or months

Hurricane Ecology

Hurricanes are unique to areas that have a surplus of warm coastal waters. For this reason, hurricanes form within 25° of the Equator because this is where warm, tropical waters are found. Furthermore, hurricane activity "generally occurs over the oceans in regions where sea surface temperatures (SST) exceed 26° C (~78° F)."[22] As expected, an increase in global temperatures has been met with an equally significant increase in SST.

Hurricanes commonly develop catastrophically high wind speeds capable of tumbling structures and mobilizing ocean waves (i.e. coastal storm surge). This occurs while the hurricane simultaneously accumulates millions of gallons of water, which will be deposited onto inland environments- both urban and natural. Hurricanes are notorious for their beautiful spiral shape, but this shape plays a major role in the ferocity and speed of a hurricane (Fig. 2).

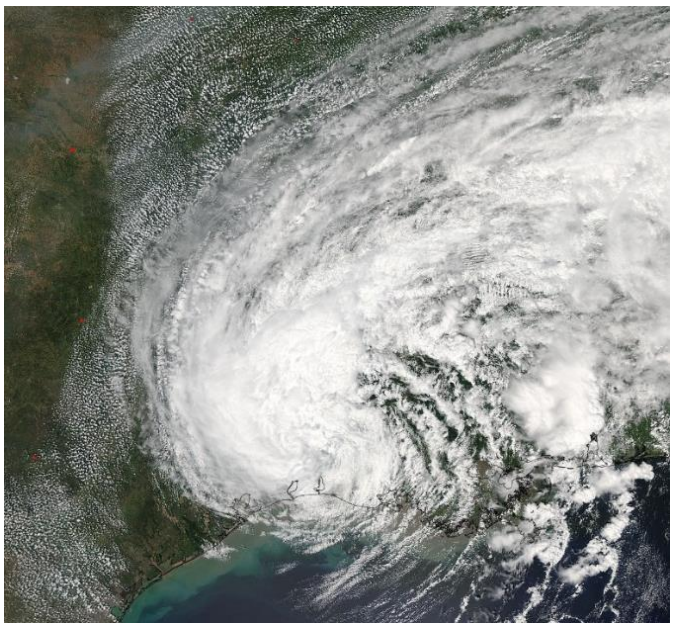

FIGURE 2. ON AUG. 30 AT 3:20 P.M. EDT NASA'S AQUA SATELLITE CAPTURED A VISIBLE LIGHT IMAGE OF TROPICAL STORM HARVEY MOVING NORTH OVER TEXAS AND LOUISIANA. THE EYE OF THE STORM IS VISIBLE NEAR THE SOUTH COAST OF LOUISIANA / NASA GODDARD MODIS RAPID RESPONSE

[22] Hart, Dr. Robert. Hurricanes: A Primer on Formation, Structure, Intensity Change and Frequency, 20. 2

The spiral shape of a hurricane is a visual representation of the intense wind speeds it exhibits. A hurricane's winds rotate and interact with the eye of the storm, which is located in the center of the system. To achieve this spiral formation, a storm typically requires a small, closed circulation system with higher temperatures than normal. In this case, these warmer temperatures are usually supplied by the Gulf of Mexico's steady supply of active thunderstorms throughout the summer. With a considerable concentration of thunderstorms near the center, a storm can develop into a tropical storm and ultimately, into a full-fledged hurricane (Figure 3). This transformation relies on heat collecting in the center of the circulation. The Earth's rotation on its axis also interacts with these events to fully realize the spiral shape we rely on to detect hurricanes. The accumulation of precipitation inside the growing system lowers the surface pressure of the hurricane. This compression of the system strengthens the circulating winds while diverting pressure throughout the hurricane. The difference in pressure throughout the system causes wind to rush inward towards the eye of the storm, and as the storm increases in size, it becomes easier for it to grow because the eye of the hurricane promotes evaporation and accelerates wind speeds. Consequently, the system can only be slowed or weakened by the sudden absence of warm water and heat.[23]

[23] Hart, Dr. Robert. "Hurricanes: A Primer on Formation…"

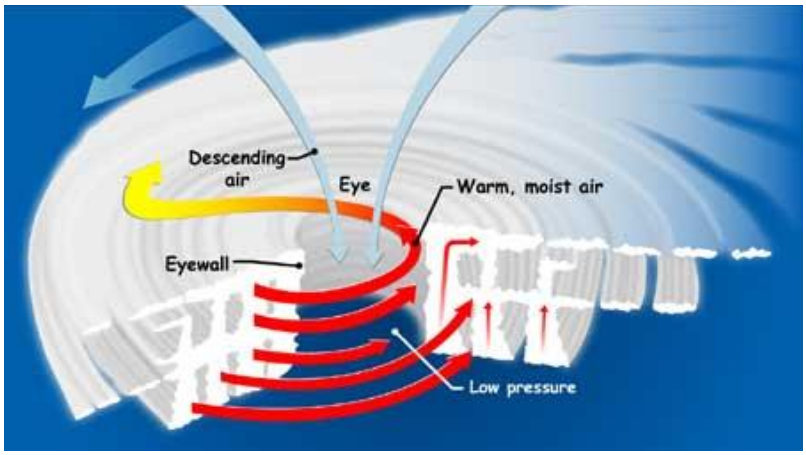

FIGURE 3. A TRANSECT OF A HURRICANE. THE SMALL RED ARROWS SHOW WARM, MOIST AIR RISING FROM THE OCEAN'S SURFACE, AND FORMING CLOUDS IN BANDS AROUND THE EYE OF THE STORM. THE BLUE ARROWS SHOW COOL, DRY AIR SINKING INTO THE EYE OF THE STORM BETWEEN THE BANDS. / NASA

Political Ecology of Hurricanes

Hurricanes can be described in terms of their political ecology. Political ecology in this sense refers to the relationship between nature and society, specifically the political and economic aspects of society. As previously noted, even the changes we are seeing in global temperatures can be linked to humans. Furthermore, hurricanes traverse and affect landscapes across diverse political regions, and their very origin can be traced to locations near and far. For instance, the formation of tropical cyclones in the Atlantic Ocean is commonly attributed to an atmospheric wave that originates in northern Africa.[24] This atmospheric wave, called an easterly wave, travels over and across the Atlantic Ocean until sufficiently warm waters feed into it and create hurricanes via the processes mentioned above. Since weather patterns halfway across the world are causing devastation halfway across the world, clearly, there must be a cooperation across parties. The following paragraphs will support this claim by listing and describing how

[24] Hart, Dr. Robert. "Hurricanes: A Primer on Formation…"

humans across the world are at fault for altering global climate patterns. To achieve this, I will turn back to Houston's history as the "energy capital of America."[25]

Houston, like many other cities across the United States, experienced unprecedented growth following the discovery of oil in the late 1800s and its production as the main nonrenewable energy source for the country by the mid-20th century.[26] The environmental degradation that would arise from the processing and manufacturing of oil and petroleum products would surpass that of coal. Like coal and natural gas, oil is formed through a process spanning millions of years. For oil to form, dead plants and animals are compressed and chemically altered under many layers of sediment. Rather than being decomposed by fungi and microbes, the biomatter is stored and compressed underground, where the carbon that would have been released by decomposers remains locked away until humans retrieve it. Once humans utilize fossil fuels, the carbon that should have been sequestered in underground sinks is released into the atmosphere, which becomes saturated with much more carbon than normal.

Fossil fuels have been singled out as a leading cause of climate change because of the heavy land-use change associated with retrieving the resource as well as the energy required to process and refine a product that is inefficient in its energy output. The main argument against fossil fuels is that they require too much energy to retrieve, process, and utilize as well as that they produce dangerous quantities of carbon that are reintroduced and stored in the atmosphere. Not only that, but the energy that is used to transport, process, and refine these fossil fuels also release carbon in the process. Carbon is not inherently dangerous. The problem arises when too much of it is expelled into the atmosphere over a sustained period of time as there is no feasible way to rid the atmosphere of it. Spikes in atmospheric carbon are dangerous because carbon

[25] Melosi & Pratt. *Energy Metropolis.* 3
[26] Melosi & Pratt. *Energy Metropolis.* 4

behaves as a greenhouse gas. That is, certain volatile compounds, such as carbon, methane, and water vapor, interact with the sun's rays as they penetrate Earth's atmosphere. Rather than allowing the sun's infrared beams to exit the Earth's atmosphere, these greenhouse gases absorb and react with the beams, resulting in a considerable release of heat energy that remains trapped in our planet. To make matters worse, increases in atmospheric carbon causes a positive feedback from water vapor as trapped heat cause more water to evaporate into the atmosphere. This process further traps heat as water vapor reacts with infrared light. Burning fossil fuels is clearly shifting the balance of our atmosphere in complicated ways, but one thing remains clear: rising global temperatures are warming global surface waters, which creates the perfect conditions for powerful hurricanes to form. Humans have already altered the Earth's climate in significant ways; it is now up to us to attempt to reverse the mistakes we have made. After all, IPCC claims we have 12 more years to do so.

CHAPTER 2

"The United States is no longer a biracial society of blacks and whites exclusively. But even though the browning of the nation-rapid growth in Hispanic populations- is changing the racial relations landscape, black-white disparities are for the most part still the greatest of all racial challenges in the country."
– Robert D. Bullard, *The Black Metropolis in the 21st Century*

Demographics and Environmental Racism

Described as an "archetypal twentieth-century city," Houston is a "multimodal, decentralized, and expansive metropolis" known for its energy industry and "consummate suburban society." Initially a heavily industrial "freeway city," Houston has undergone many changes as the city's population and diversity have increased. More important still, the unrelenting commitment to economic growth has riddled the booming metropolis with dangerous ozone production, the presence of over a dozen Superfund sites throughout the region, water pollution, and uncontrolled flooding events. Though these problems are surely of concern to those living in the city, environmental issues often impact minority groups and people of color, specifically low-income minority groups, much more frequently and to a much higher degree compared to white and affluent people. This chapter aims to describe the distribution of black communities across Houston as established by racist housing practices throughout the 1900s. By exploring Houston's history of Jim Crow laws, I map out the existing watershed onto segregated communities throughout the city.[27]

Unlike many American megacities, Houston is characterized by its obvious lack of zoning laws, which has contributed to the general chaos associated with how the city expanded.

[27] Melosi & Pratt. Energy Metropolis: 105

The lack of a zoning ordinance in Houston means that structures can be erected anywhere in the city regardless of purpose or geography. Though generally unplanned, downtown Houston still remains the focal point of the Gulf Coast. A general understanding of the layout of Houston will aid when I describe the demographics of the city (Figure 4).

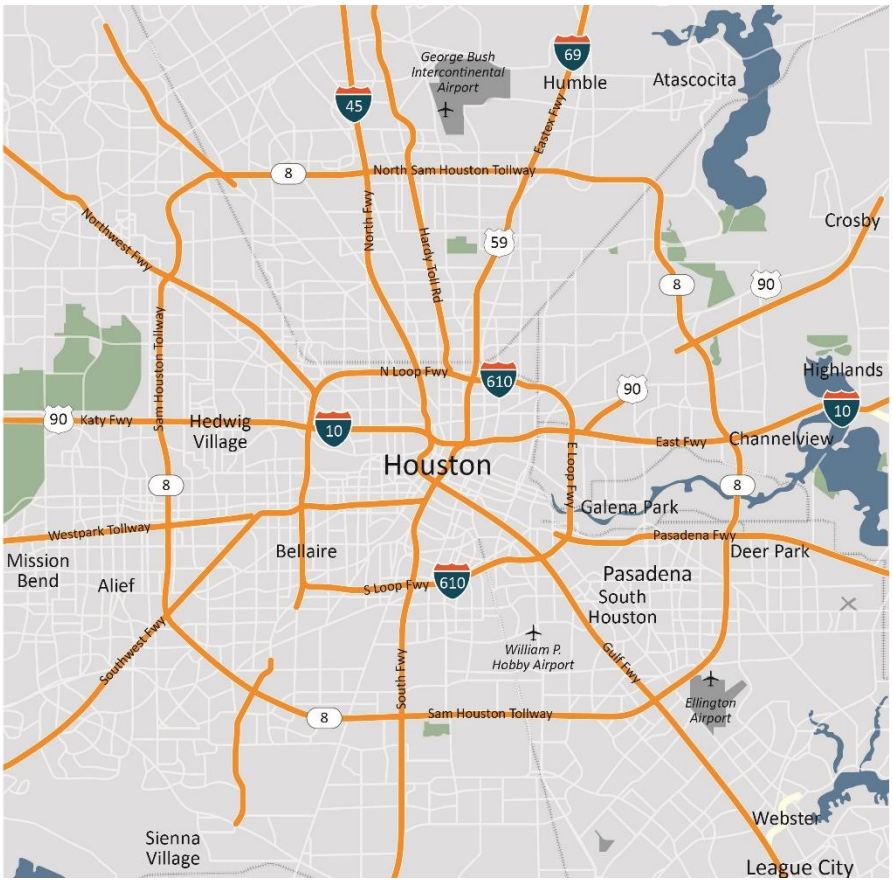

FIGURE 4. A MAP OF HOUSTON, TX DEPICTING THE MAJOR HIGHWAY SYSTEMS IN YELLOW. DOWNTOWN HOUSTON LIES AT THE CENTER AND IS OUTLINED BY HIGHWAY 610. BODIES OF WATER ARE MORE PROMINENT ON THE EASTERN SIDE OF THE CITY, WHICH IS NEARER TO THE COAST.

Robert D. Bullard, deemed the "Father of Environmental Justice" and revered as a scholar of black politics in the South, states in his book entitled *The Black Metropolis in the Twenty-First Century: Race, Power, and Politics of Place* that "race and class are still underlying factors that explain the sociospatial layout of most of our cities, suburbs, and metropolitan regions, including quality of schools, location of job centers, housing patterns, environmental

quality, commercial and business development, access to health care, and a host of other quality-of-life indicators for African Americans."[28]

Historically, a majority of black and poor populations in Houston have been located within the confines of the "south-central and southeast portions of the city into northeast and north-central Houston." Black communities can now be found across the northwest and southwestern parts of the city, but many of the impoverished neighborhoods remain unchanged (Figure 5). African-Americans now make up one-fourth of the city of Houston and have spread across most parts of the city, but their history remains rooted in class divides.

Segregation in Houston dates back to the birth of the energy sector at the turn of the century. Conservative rural populations from west Texas and Louisiana migrated into Houston with hopes of reaping the benefits of the energy sector, and they enforced the segregation and oppression from which the city was built on. Nonetheless, by 1950 black communities throughout Houston had become well established and were on the rise. The largest concentration of black individuals was located in "three major segregated neighborhoods- the Fourth Ward, Third Ward, and Fifth Ward" (Figure 5). These three wards are the focus of this section because they have historically been inhabited by mostly African-American families, and they are considered low-income communities. Furthermore, these areas have historically experienced higher levels of flooding as well as unwarranted proximity to refineries, factories, and other heavily polluting industries. In this case, racism uses a seemingly invisible hand to map out the landscape.[29]

[28]Bullard, Robert D. *The Black Metropolis in the Twenty-First Century: Race, Power, and Politics of Place.* Lanham: Rowman & Littlefield Publishers, 2007: 1

[29] Melosi & Pratt. Energy Metropolis: 207

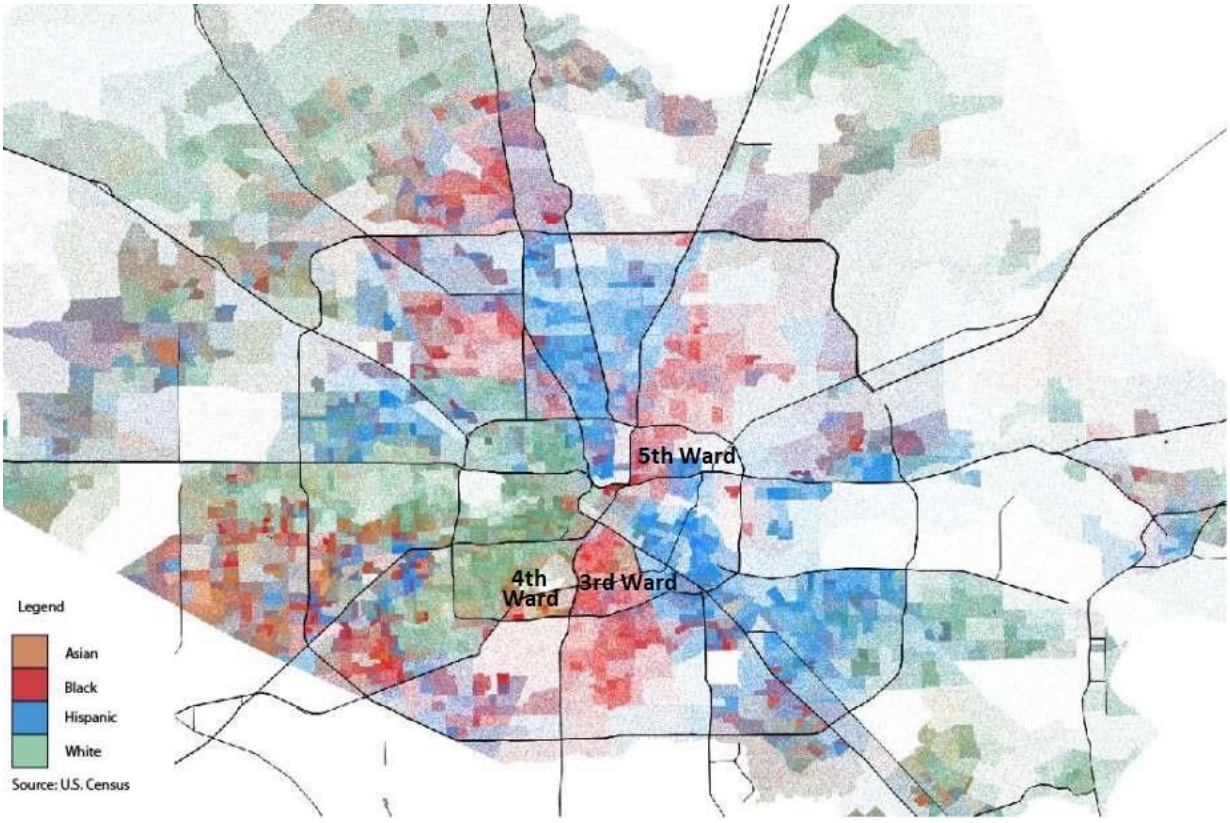

FIGURE 5. THE 2017 U.S. CENSUS SHOWS THE DISTRIBUTION OF DIFFERENT ETHNIC GROUPS ACROSS THE CITY. BLACK COMMUNITIES ARE DEPICTED BY THE RED COLOR AND ARE PREDOMINANTLY IN THE SOUTHERN AND EASTERN PARTS OF THE CITY.

Unfair Housing Practices

Many people tend to associate racial segregation with private practices or individual preferences. That is, it is believed that when people of color move into neighborhoods there is a "white flight" that is followed by an even bigger influx of minority groups into the area. This more cultural and less nuanced explanation for racial segregation is often referred to as "*de facto* segregation" because it hints at its inevitability.[30] This explanation, though prevalent, has been refuted and debunked time and time again by passionate environmentalists, historians, and policy experts. Though some elements of *de facto* segregation may hold truth, such as the initial prejudice held by whites when minorities settle into new areas, the real fault lies with institutions

[30] Rothstein, Richard. *The Color of Law: A Forgotten History of How Our Government Segregated America*. Liveright Publishing Corporation, a Division of W.W. Norton & Company, 2018. vii

that normalize the systematic oppression of blacks and poor people. Richard Rothstein, an expert of Jim Crow laws and racial segregation in US housing practices, introduces "what courts call *de jure:* segregation by law and public policy." This more dangerous and malicious type of segregation was possible through the "purposeful use of public housing by federal and local governments" following the Great Depression, the development of insurance policies that subjugated African-American applicants to unfair home prices, and by outright denying minority groups from moving into areas that were historically white or already "integrated enough." Not only were people of color systematically wrangled into certain neighborhoods, they were also forced to endure quickly deteriorating infrastructure to repel white and/or wealthier individuals. Slightly more obvious have been the operations to locate factories, landfills and other unwanted facilities near poor and minority neighborhoods. Furthermore, blue-collar workers have also settled in areas surrounding these factories, which has increased the proportion of low-income individuals in these neighborhoods. Over time, these neighborhoods would urbanize and reach a much higher level of flood risk than before.[31]

A common misconception associated with *de facto* segregation is that black families have been unable to move into predominantly white middle-class communities and are still unable to do so merely because they lack the means. In this case, segregation is just another marker of their own status. On the surface, this may seem like a valid argument, but it takes a deeper understanding of income gaps between low and middle-income groups to fully understand how thoroughly racism is embedded in housing segregation. Some people are able escape poverty through strenuous work, dedication, and to some extent luck and timing, but unfortunately, this tends to be a small percentage of low-income individuals. Though it may be easy to just blame

[31] Rothstein, Richard. *The Color of Law*

someone for not working hard enough or for not wanting to better for themselves, the truth is that predominantly black and poor neighborhoods have been molded and built over the foundations established by class and racial divides in the twentieth century.

In Houston and around the country, black communities have historically been considered "opportunity-poor" communities because of the fact that "businesses systematically avoid African-American areas of all class levels and selectively target white areas for their operations." Furthermore, there are many recorded instances of banks giving credit extensions on unfair terms for people living in specific geographic areas or denying mostly black communities equal access to residential, consumer, and small business credit. What these unfair practices end up doing is creating poor, working class, or minority neighborhoods with fewer choices and opportunities, such as affordable housing, good-quality schools, high-paying jobs, businesses, green spaces, parks and even hospitals and police stations.[32]

We then come back to the question of income gaps, and the ability of low-income communities to pull themselves out of poverty. Given that black neighborhoods are disproportionately less likely to have successful businesses or equal opportunities, it has been observed that these individuals tend to have "smaller disposable incomes and fewer saving" which keeps these families from accumulating wealth and moving into middle-class communities in the long run.[33] Banks and insurance companies are still guided by their predecessors to this day, though perhaps in less obvious ways, and poor and minority groups continue to have a hard time moving into lower-risk neighborhoods. Unfair housing and zoning practices have rendered minority groups vulnerable to disasters, specifically the flooding

[32] Bullard, Robert D. *The Black Metropolis in the Twenty-First Century: 2*
[33] Rothstein, Richard. *The Color of Law:* 154

associated with hurricanes. The following section will map out Houston's most vulnerable locations in relation to the racial and class groups inhabiting these areas.

Minorities in the Floodplains

Following Hurricane Rita, a category 5 hurricane that made landfall in Houston on September, 2005 and caused over a hundred fatalities as well as over $18 million in damages, the city of Houston's Harris County Flood Control District created an online educational mapping tool using data obtained and updated by the Federal Emergency Management Agency (FEMA).[34] This online tool, named the Flood Insurance Rate Map (FIRM), can be used to locate floodplains, which will be useful in our analysis of demographics across the city. This relationship is clearly summarized in figure 6.

Mapped onto the Flood Education Mapping Tool are nine of the most dangerous and most impoverished neighborhoods in Houston according to the U.S. census. The average income across these neighborhoods ranges from $12,477 to slightly above $50,000 in the wealthier locations, which is still $5,000 below the average income in Harris County.[35] Just by looking at average yearly income, school quality rankings, and crime rates in these locations, we see a definite trend between demographics and flood-risk. Furthermore, the nine sites labeled in figure 6 are predominantly African-American or Latinx, except for Midtown (site 3) and Meyerland (site 7) which are experiencing increasing gentrification. Clearly, a large portion of Houston runs the risk of encountering floods, but historically, the wealthiest neighborhoods that are also near

[34] "Harris County Flood Education Mapping Tool" Harris County Flood Education Mapping Tool. Accessed November 5, 2018. http://www.harriscountyfemt.org/.
[35] U.S. Census Bureau, "US Census Bureau QuickFacts: Houston City, Texas," 2018, https://www.census.gov/quickfacts/fact/map/harriscountytexas,houstoncitytexas#viewtop.

floodplains have experienced little infrastructural damage due to more sophisticated drainage systems paid for by more abundant public tax dollars. Areas marked by the green boxes are among the wealthiest neighborhoods in Houston, and they definitely keep themselves elevated and distant from the 100-year floodplains, which are marked by the darker blue colors in figure 6.

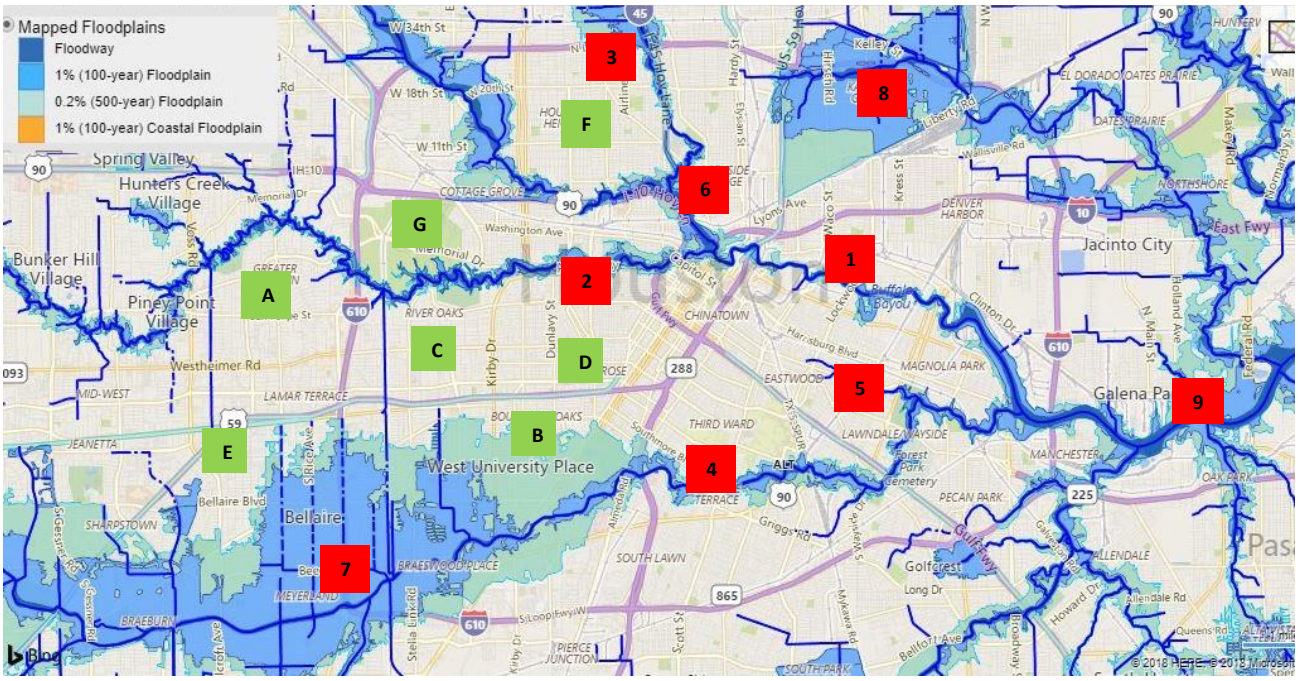

FIGURE 6. POOREST NEIGHBORHOODS IN RED 1=SECOND WARD; 2=MIDTOWN; 3=NORTHLINE; 4=THIRD WARD; 5=EASTWOOD; 6=NORTHSIDE VILLAGE, 7=MEYERLAND, 8=KASHMERE GARDENS; 9=GALENA PARK. WEALTHIEST NEIGHBORHOODS IN GREEN A= HUNTER'S CREEK VILLAGE; B=WEST UNIVERSITY PLACE: C=RIVER OAKS: D=MONTROSE: E=BELLAIRE; F= THE HEIGHTS; G= CRESTWOOD)/ HARRIS COUNTY FLOOD EDUCATION MAPPING TOOL

Houston's current struggle with the effects of climate change and hurricanes is deeply embedded within the racial and class divides that have tortured the city since its establishment in the mid-1800s. Through an exploration of racist housing practices in the growth of Houston, one can conclude that segregation during this time served a very real purpose. The first suburb of the city, marked by the letter F, was the Houston Heights. With seven historic districts, the Heights was founded in 1896 by Oscar Martin Carter and Daniel Denton Cooley, members of the Omaha

and South Texas Land Company.[36] As one could have guessed, the men were drawn to this location because it was near downtown yet had a significant rise in elevation, which would keep both floods and mosquitoes at bay. From the very beginning of development in Houston, we see the most appealing and safest location become inhabited by the privileged. Wanting to maintain their properties' value and their families safe, members of the higher class had the resources necessary to build the city in their image. This is exactly why Houston's Historic District predominantly lies in The Heights, Montrose (green D), and West University Place (green B), three of the wealthiest and most elevated neighborhoods in Houston (Fig. 6). Recognizing the dangers of developing in low elevations, Downtown Houston stands about 50 feet above sea level, which is only 40 feet below the highest elevation in the city.[37]

Diversity began to rise throughout the 1900s due to the boom in the energy sector and the decline in cotton production due to its mechanization. Thus, older neighborhoods that were already fully developed, such as the three mentioned above, were out of reach for incoming minorities. Originating from the slave plantation economy, Houston has been plagued by prejudice and racism since its infancy, and these factors remained an integral part in the growth of Houston under Jim Crow laws in the second-half of the 20th century. I conclude that Houston's very first neighborhoods were opportunistically chosen by white elite in the most elevated locations to avoid disease and property damage, and by developing these locations, they laid the foundation for the segregation of future populations into unappealing and dangerous floodplains.

[36] Guillen, Darla, "How the Heights Became the Heights - Houston Chronicle," September 11, 2017, https://www.chron.com/neighborhood/heights/article/How-the-Heights-became-the-Heights-10443862.php.
[37] "Topographic Map Houston," topographic-map.com, accessed November 17, 2018, http://en-us.topographic-map.com/places/Houston-6818619/.

CHAPTER 3

"How often have I lain beneath rain on a stranger roof, thinking of home"
-William C. Faulkner, "As I Lay Dying"

Tent-Cities in the Underpass

Clusters of homeless people have appeared throughout the City of Houston following Hurricane Harvey. What were once uninhabited underpasses have become the living quarters for hundreds of Houstonians. The rise in homelessness across the city is painfully evident. A simple explanation for the rise of homelessness in Houston may be that there was absolutely nothing anybody could do about the torrential rainfall once Harvey made landfall. In reality, the Gulf Coast is no stranger to hurricanes, and the fact that the region was built on flat prairies, marshes, and coastal ecosystems does not help. Still, ecology and geography alone are not to blame for the sudden spike in the number of displaced Houstonians. In this chapter, I argue that government agencies failed to help citizens rebuild after Harvey in part because the magnitude of the devastation was unprecedented but also because flood insurance via the National Flood Insurance Program (NFIP) and aid from the Federal Emergency Management Agency (FEMA) were unavailable or insufficient for low-income communities.[38]

Hurricane Harvey rattled neighborhoods across Houston that had never experienced flooding before. In totality, Harvey unleashed an astounding 50 inches of rain in a span of just three days—slightly above the annual average rainfall in the region. Houston was not ready to

[38] Despart, Zach. "Flood Insurance Paid Homeowners $100,000 More than FEMA after Harvey, Expert Says." HoustonChronicle.com. June 07, 2018. Accessed November 15, 2018. https://www.houstonchronicle.com/news/houston-texas/houston/article/Harris-County-homeowners-without-flood-insurance-12973727.php.

withstand the devastation, but more importantly, homeowners were far less prepared to rebuild afterwards. Simply put, Hurricane Harvey taught Houstonians just how complicated the effects of natural disasters can be on a heavily urbanized metropolitan city like Houston.

When discussing the nature of aid, specifically for a flood event, it is important to take into consideration the following potential sources of aid: private insurance companies, the National Flood Insurance Program (NIFP), the Federal Emergency Management Agency (FEMA), and small-scale local and federal aid. Of these sources, private flood insurance policies are largely employed by large-scale companies because of how expensive, yet expansive, the coverage is. In a similar note, federal aid has been distributed intermittently as problems arise in the region, and the local government has been able to relocate over a hundred individuals so far, yet nearly 154,000 homes were flooded by Hurricane Harvey.[39] For these reasons, we must turn towards the NIFP and FEMA because they played a much larger role in the reconstruction of Houston.

NIFP and FEMA

First and foremost, there is a sharp contrast between the aid provided by NIFP versus FEMA. Flood insurance through NIFP is a reliable, and preventative, resource to fall back on when things go awry where FEMA provides immediate aid to those in desperate need of it. In fact, following Hurricane Harvey, FEMA announced that it wanted to double the amount of insured structures in the U.S. by advertising insurance policies in high-risk flood zones. By insuring the most at-risk communities, FEMA can maximize its very limited resources for those who truly need it (i.e. people who cannot afford flood insurance). Furthermore, it benefits

[39] Despart, Zach. "Flood Insurance Paid Homeowners $100,000 More than FEMA...

homeowners to purchase flood insurance from NIFP because it amounts to, on average, $100,000 more than FEMA is able to provide to any given individual.[40] To become insured, individuals pay a monthly premium to NIFP like they would to any other insurance company, and this monthly payment amounts to around $500 a year (this value can rise to more than $2,000 for homes in floodplains).[41] Right away, class division dictate who will be able to rebuild and who will have to take their chances with the couple thousand dollars FEMA is able to provide. Recall from the previous chapter that the poorest neighborhoods in Houston were also among the closest to floodplains. How can they be expected to pay for flood insurance?

Though low-income groups may be unable to afford flood insurance, a majority of the individuals that live in floodplains and that *can* afford flood insurance still lack insurance. Consequently, over 80% of the affected homes in Houston were not insured. This reality rises primarily because insurance policies are a luxury that many cannot afford, but also because FEMA and the federal government have misinformed people of the nature of floods in a unique city like Houston.[42] Still, NIFP has its own issues since it has gone over $25 billion in debt ($5 billion short of their limit) following Hurricanes Katrina and Sandy, so even this source of aid is gradually shrinking.[43]

Blaming individual homeowners for not investing in flood insurance is a fruitless endeavor because a) insurance policies can amount to over $2,000 a year and b) FEMA and the

[40] Lozano, Juan A., and Meghan Hoyer. "Flood Insurance Uptake Rates Rise in Texas Following Harvey." Insurance Journal. July 31, 2018. Accessed November 15, 2018. https://www.insurancejournal.com/news/southcentral/2018/07/31/496541.htm.
[41] Long, Heather. "Where Harvey Is Hitting Hardest, 80 Percent Lack Flood Insurance." The Washington Post. August 29, 2017. Accessed November 15, 2018. https://www.washingtonpost.com/news/wonk/wp/2017/08/29/where-harvey-is-hitting-hardest-four-out-of-five-homeowners-lack-flood-insurance/?noredirect=on&utm_term=.a9b23203738b.
[42] Despart, Zach. "Flood Insurance Paid Homeowners $100,000…"
[43] Long, Heather. "Where Harvey Is Hitting Hardest…"

federal government have repeatedly failed to accurately classify flood risk zones throughout the Greater Houston area, which has thwarted wealthier homeowners from confidently investing in flood insurance. Essentially, the federal government, and to some extent local and state officials, have neglected conducting meaningful research around the quickly developing city landscape and its effects on existing watersheds and floodplains. This is especially evident in the treatment of federally-backed housing units in high-risk flood zones because they are required by law to have an active flood insurance policy, yet many were not actually insured.[44] Locations deemed "Special Flood Hazard Areas" (SFHAs) by FEMA are required to have flood insurance, but these SFHAs became virtually indiscriminate once a majority of the city was underwater. Evidently, the politics surrounding financial aid during disasters is complex, but this scenario serves as a reminder of just how inherently unequal government institutions can be.

Homelessness by the Numbers

When disaster strikes, there seems to be an air of heroism in the city, which translates into individuals offering their own resources to help people out of dangerous situations (Figure 7). Images of burly men carrying frail seniors out of their flooded homes became commonplace on TV and newspapers. Furthermore, people tried to help each other in any way that they could, and this was especially apparent on social media. During Hurricane Harvey, the mornings following a heavy rainfall would be flooded with pleas for help locating friends and loved ones.

[44] Lowry, Michael, Rhome, Jamie and Berg, Robbie. "Why Some of the Nation's Top Hurricane Experts Bought Flood Insurance." Inside the Eye. May 09, 2018. Accessed November 15, 2018. https://noaanhc.wordpress.com/2018/05/09/why-some-of-the-nations-top-hurricane-experts-bought-flood-insurance/#_ftn1.

Images of individuals that had gone missing during the night would dominate my Facebook feed. A sense of urgency always lingered in the air, and we all desperately wanted to help.

FIGURE 7. AN EXAMPLE OF THE WATER RESCUES THAT WERE ONGOING DURING HARVEY IN HOUSTON ON 27 AUGUST 2017 / DAVID J PHILLIPS (ASSOCIATED PRESS)

Though this horrific event did bring out the good in people, it cannot go unnoticed that our government left us to fend for ourselves. Aid did end up arriving, but why were families like mine left without access to food for days at a time? Why have some families returned home but other are still forced to live in shelters and underpasses? Why are citizens expected to carry the slack for the government, which should be maintaining and consolidating infrastructure? In this section, I aim to uncover just how bad the homeless situation has gotten in Houston a little over a year after Harvey made landfall in August 2017.

The Coalition for the Homeless has played a pivotal role in tracking homelessness across several counties in the region with a particular focus on those that became homeless because of Hurricane Harvey. As defined by the Department of Housing and Urban Development (HUD),

an individual is considered homeless if they are "staying in an emergency shelter, transitional housing, a safe haven with beds specifically for homeless persons" or living on the street unsheltered. Using this definition, the Coalition for the Homeless concluded that Houston's Harris County had 91% of the total number of recorded homeless people in the region. Furthermore, the region, predominantly Harris County, experienced an increase in homeless populations from 3,412 to 3,866 with a majority of the increase being attributed to a spike in unsheltered individuals (1,084 unsheltered in 2017 to 1,540 unsheltered in 2018). Of the 3,866 homeless people recorded in this survey, 18 percent of them claimed to have become homeless because of Hurricane Harvey.[45] This is approximately 696 of the 3,866 people recorded, and of these 696 displaced individuals, 456 are entirely unsheltered meaning that over 65 percent of the individuals that lost their homes to Harvey were unable to secure shelter or enough aid to return home. This comes as no surprise since FEMA ended up accommodating over 42,000 people in temporary shelters. Furthermore, in a period of just 30 days, approximately 270,916 households were granted $571.8 million in FEMA aid (about $2,000 per household) for temporary housing, basic repairs, and other essential needs.[46] Temporary housing was provided after Harvey for a maximum period of one month, and repairs were expected to average upwards of $15,000 per household. In a city where the median price of a home is $289,950, $2,000 could either shelter and feed a family for a few months or be used to partially clean up a flooded home.

[45] The Coalition for the Homeless, "Local Data and Research | Coalition,"
[46] FEMA, "Historic Disaster Response to Hurricane Harvey in Texas."

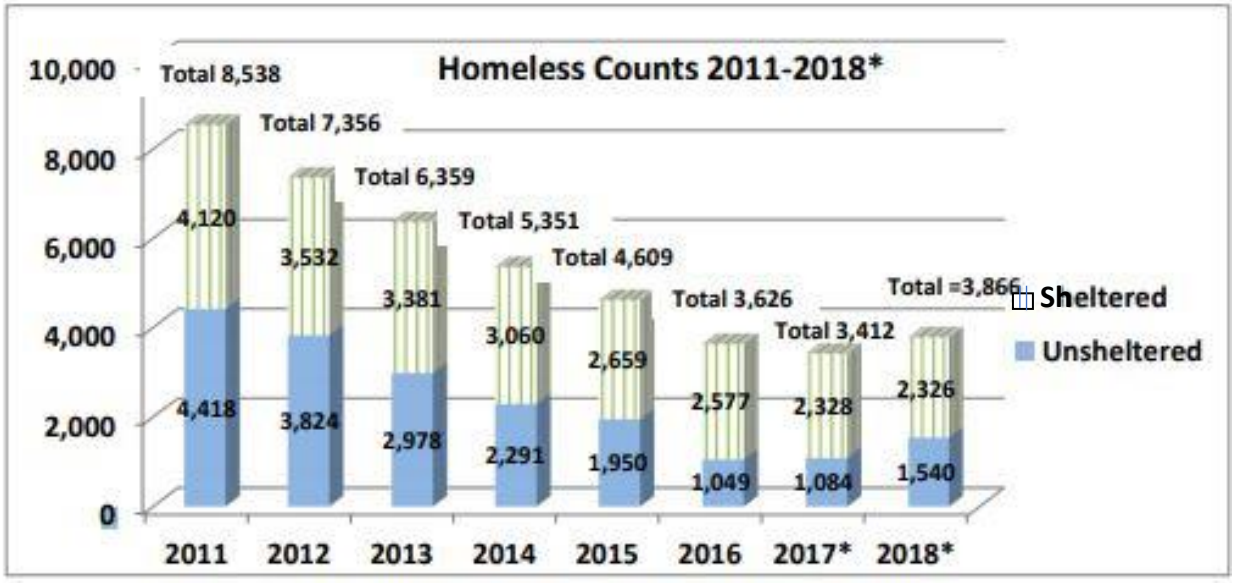

FIGURE 8. DATA COLLECTED IN HARRIS, FORT BEND, AND MONTGOMERY COUNTIES SHOW AN INCREASE IN HOMELESS INDIVIDUALS FROM 2017 TO 2018/ THE COALITION FOR THE HOMELESS

Clearly, the institutions put in place to aid during times of extreme emergencies are lacking in direction, capacity, and efficiency, but there is also something to be said about the lack of affordable (and fortified) housing in Houston. Low-income groups, who now make up a majority of the unsheltered homeless individuals, cannot be expected to reenter the housing market when an increase of 4.1 percent has been observed in the average rent for single-family homes and an increase of 2.2 percent has been observed for the average rent for townhomes and condominiums following Hurricane Harvey.[47] Low-income groups would most likely avoid both single-family homes and townhomes anyway since they still cost about $1,500 per month. The main problem now lies with the fact that Houston has an average of 18 homes available for every 100 extremely low-income renter households. This means that if every available low-income house in the region were rented out to the current population of homeless people in Houston,

[47] Solis, Ali "Houston Post-Harvey Is Ground-Zero for the Rental Affordability Crisis [Opinion] - HoustonChronicle.Com," May 15, 2018, https://www.houstonchronicle.com/opinion/outlook/article/Houston-post-Harvey-is-ground-zero-for-the-rental-12914050.php.

there would still be over 3,100 people living in shelters and on the streets. This is clearly a problem.

Hurricane Harvey exacerbated the homelessness problem that Houston already had before the storm, but this sudden rise in homelessness has made several things abundantly clear. First, Houston's long history of unregulated sprawl has led to a general disregard for the state of the environment and the effects of urbanization on biotic and abiotic factors. Second, underfunded federal institutions and agencies have demonstrated that they are not fully capable of supporting a city the size of Houston during and after a disaster. Third, low-income communities with affordable housing tend to be closest to floodplains while still having the least structural fortification to withstand flooding events. Combined, these three points underscore the main argument of this thesis: that low-income communities have been systematically forced to endure disproportionately more environmental problems compared to their wealthy and white counterparts. Having discussed the faults of our federal and local governments during and directly after Harvey, the problematic history of Houston development under Jim Crow laws, and the role of humans in propagating stronger and stronger hurricanes via climate change, I will now explore the future of the Texas Gulf Coast, for these next few years are vital for the future of the region and its people.

CHAPTER 4

"A man should never be ashamed to own he has been in the wrong, which is but saying that he is wiser today than he was yesterday."
-Alexander Pope on the value of Learning

Looking Forward

Countless hurricanes have ravaged Texas's Gulf Coast, and, every single event has had a lasting impact on at least a proportion of the population. Still, government institutions at the local, state, and federal level have neglected the safety of large metropolitan cities like Houston for the sake of growth and development. Rather than investing in flood and hurricane research, the federal government has recently enacted budget cuts for such government agencies as the Environmental Protection Agency (EPA) and the Federal Emergency Response Agency (FEMA), which are solely dedicated to the management, conservation, and preservation of nationwide environments, including the task of protecting and aiding communities during natural disasters.[48] Budget cuts and mismanagement have become apparent in how the federal government is responding to the needs of the city and its inhabitants.

Prior to Hurricane Harvey and to some extent even after, Houstonians have had a limited understanding of the environment directly around them. Having attended public school in Texas for the entirety of my childhood, matters of pollution and environmental degradation were not discussed, and when they were, the topics rarely covered ecosystems in Texas. The general patchiness in my understanding of the natural world became that much more evident after I

[48] Environmental Protection Agency, "EPA's Budget and Spending." EPA. July 09, 2018. Accessed November 13, 2018. https://www.epa.gov/planandbudget/budget.

began my pursuit of an undergraduate degree in Environmental Analysis. As Melosi and Pratt point out in their book, *Energy Metropolis*, up until very recently, most members of society, whether rich or poor, white or minority groups, have admired the opportunities and the unfettered growth that Houston has provided them and their families under the heavily polluting industries of oil and natural gas.[49] In fact, these industries have created over two dozen Superfund sites across the Gulf Coast region.[50] Eight of these heavily contaminated sites lie in the center of Houston, within the circumference of Interstate 610. It would not be until the summer of 2018 that I myself would discover these hidden truths about my hometown.

During the summer of 2018, I became a member of Texas Campaign for the Environment (TCE), a non-profit organization that campaigns year-round in Houston and Dallas with hopes of mobilizing constituents to reach out to their representatives to tackle environmental problems. The 2018 TCE campaign aimed to get more Superfund sites cleaned up following a successful 2017 campaign that convinced former EPA administrator Scott Pruitt to cleanup the San Jacinto Tar Pits. What at first seemed like a huge victory quickly diminished since Texas's lax environmental regulations meant that the area would be considered clean even when toxins and contaminants remained present at the site. Still, the passionate work that environmental groups, like TCE perform for their communities is invaluable, and the fear that Hurricane Harvey brought to Texas has surely helped in propelling community members towards change at the local and state level. In fact, pressure at the local and state level has compelled public and private research universities, like the University of Houston, Rice University, and even distant schools in

[49] Melosi & Pratt. *Energy Metropolis*. 9.

[50] In collaboration with the U.S. EPA, the Superfund Program was founded in 1980 with the purpose of funding the cleanup of sites contaminated with hazardous substances or pollutants. Usually, contaminated sites must reach a predetermined level of pollution before being deemed a Superfund site, and after it becomes a Superfund site, millions of dollars go towards funding the research and subsequent cleanup of a site.

North Texas and Louisiana, to develop plans for how to protect the city against hurricanes and floods.[51] Sixteen hurricanes of category 3 or higher have made landfall in the Texas Gulf Coast since the Galveston Hurricane of 1900, which was the deadliest natural disaster in U.S. history with fatalities between 6,000 and 8,000 individuals (Figures 9 & 10).[52] Several plans have recently been brought forth that aim to curb the effects of hurricanes and flooding on the city of Houston. This chapter analyzes and criticized several projects proposed by state and federal officials with aims of consolidating the City of Houston and the Texas Gulf Coast.

FIGURE 9. THIS IMAGE DEPICTS A GROUP OF CHILDREN POSING IN FRONT OF A HOUSE THAT WAS STRIPPED FROM ITS FOUNDATION AND SHIFTED BY THE HURRICANE'S WINDS. / LIBRARY OF CONGRESS

[51] Fulton, William and Shelton, Kyle. "One Year Later: What We've Learned Since Harvey." The Kinder Institute for Urban Research. Accessed November 13, 2018. https://kinder.rice.edu/2018/08/19/one-year-later-what-weve-learned-harvey.

[52] Burnett, John. "The Tempest at Galveston: 'We Knew There Was A Storm Coming, But We Had No Idea'." NPR. November 30, 2017. Accessed November 13, 2018. https://www.npr.org/2017/11/30/566950355/the-tempest-at-galveston-we-knew-there-was-a-storm-coming-but-we-had-no-idea.

FIGURE 10. THIS IMAGE SHOWS THE DEVASTATION CAUSED BY THE GALVESTON HURRICANE OF 1900. THE LANDSCAPE IS COMPLETELY DROWNED BY TUMBLED STRUCTURES AND HOMES. / LIBRARY OF CONGRESS

The ongoing research conducted by Rice University has been focusing on the cooperation between local communities and government officials in planning flood mitigation strategies. The rationale here lies in that local community members are better versed in their own communities, so their opinions and experiences should carry weight in these discussions. Rice University has tackled this issue using a mixture of scientific research as well as a nuanced understanding of policies and traditional knowledge of the environment. Students at Rice identified several key points for the successful and efficient implementation of natural disaster mitigation strategies in Houston. First and foremost, data surrounding the geography of the Gulf Coast, including floodplains and active watersheds, as well as the locations that run the highest risk of flooding should be actively and reliably collected as well as effectively and accessibly presented to the general public. Along these lines, local and outside expertise should be employed to increase the effectiveness of local action as well as to determine the most vulnerable populations and how to

best aid them before, during, and after a natural disaster. Finally, the researchers at Rice recognize the limitations associated with aid and research at the federal level--i.e. budget cuts, biases, ulterior motives, etc., so they suggest coming up with innovative ways to pay the individuals involved in these large-scale projects before finally planning and executing them. This study provided a general overview from which to draw inspiration for future planning. The authors inform us that the Harris County Flood Control District has been cooperating with researchers across Texas, university researchers, city officials, and Harris County constituents.[53] The passionate work and cooperation between these groups are what made the following proposals possible.

Immediately following Hurricane Harvey, several Houston area groups collaborated and drafted some preliminary demands based on the city's needs. Over the course of two months, the U.S. House of Representatives would pass several Hurricane Harvey relief packages.[54] Congress would end up allocating over $50 billion in Harvey relief by the end of 2017. Though considerate, most of this funding would end up going towards FEMA relief efforts rather than future mitigation efforts.

A sense of urgency has lingered following Harvey as Houstonians wonder how the city is going to move forward. Fortunately, diverse groups have banded together with the goal of drafting robust and logical projects aimed at mitigating the effects of future hurricanes on the region. The varying backgrounds and experiences of these individuals has naturally led to diverse project proposals with different goals, but some key themes are reiterated in these proposals. In this section I will describe some notable project proposals as well as their

[53] Fulton and Shelton. One Year Later.

[54] Arrajj, Shawn. "Houston Area Groups Propose Plan for How Third Hurricane Harvey Relief Package Should Be Distributed." Community Impact Newspaper. November 16, 2017. Accessed November 14, 2018.

shortcomings. This will be done by looking at the project proposals in chronological order following Harvey.

Rebuild Texas and a *Comprehensive Flood Protection Plan for a Better Houston*

As I mentioned before, congress has allocated funds towards the Texas Gulf Coast following Hurricane Harvey, but most of this money went towards FEMA relief efforts and to paying off "debts accumulated by the National Flood Insurance Program." In an effort to place more emphasis on rebuilding and consolidating existing bodies of water, Governor Greg Abbot proposed the *Rebuild Texas* plan, which is composed of several different projects totaling $61.8 billion in additional funding. Gov. Abbot's projects place an emphasis on consolidating Addicks and Barker Reservoirs, which *only* keep Greater Houston from experiencing catastrophic floods from the upper-west side, but this project has been heavily criticized for neglecting the safety of the rest of Harris County. Nonetheless, Gov. Abbot adopts a well-rounded approach to his project proposal and accepts the help of more educated individuals to avoid mistakes.[55]

The *Rebuild Texas* plan aims to rebuild the Gulf Coast by following three main steps. First, to facilitate and expedite the general rebuilding of any and all affected areas, "assistance [centers]" with experts on "federal and state law, federal disaster rules, state rules, government procurement, and large-scale construction issues" will guide local officials as well as community members when tackling preliminary issues. Second, assistance centers will serve as continuous links between the affected communities, state officials, and federal programs. Finally, each group and region will report back to the Governor so that he can ensure consistent rebuilding efforts across the region. The *Rebuild Texas* plan ultimately calls for a timely response to local needs

[55] Arrajj, Shawn. "Houston Area Groups Propose Plan…"

based on individual assessments, and the plan relies on the assumption that communities should be built better and stronger than before.[56]

Apart from the fortification of communities based on local needs, which makes up a large part of *Rebuild Texas*, Abbot's plan also places an emphasis on the consolidation of existing reservoirs and the construction of a third reservoir in the Cypress Creek watershed. This additional reservoir would presumably take pressure off the Addicks and Barker Reservoirs during floods. Though a pivotal step in keeping west Houston dry, this portion of Abbot's plan has been criticized for not taking into consideration issues like water flow and speed when talking about flooding trends. A strong supporter of Governor Abbot's plan has been the president of the West Houston Association, Augustus Campbell.[57] Rather than going against the governor's plan, Campbell has been fighting for the expansion of *Rebuild Texas* to what he calls *A Comprehensive Flood Protection Plan for a Better Houston* (CFPPBH). Both plans call for the immediate research and development of existing reservoirs as well as the construction of a third, new reservoir in Cypress Creek. Both plans also place an emphasis on home buyouts to remove people from harms way as well as to empty out spaces to develop and build as needed.

CFPPBH mainly differs in that it also demands the upkeep of existing bayou conveyance projects. Campbell claims that flooding events in Houston have become commonplace because of slow conveyance across bodies of water. By facilitating the flow of water out of bayous, Campbell argues that approximately 12 inches of rainfall can be expelled from the Greater Houston area in less than 24 hours. Campbell cites the Sims Bayou project as justification for increasing bayou conveyance since the 2015 project essentially kept all the homes along the

[56] Abbot, Greg. "Plan." Rebuild Texas. September 7, 2017. Accessed November 14, 2018. https://www.rebuildtexas.today/plan/.

[57] The West Houston Association is a non-profit organization that plans and develops infrastructure and public policies for the Greater West Houston area.

Sims Bayou from flooding during Harvey.[58] An overview of Campbell's *Comprehensive Flood Protection Plan for a Better Houston*, which encapsulates many of the projects proposed in *Rebuild Texas*, is shown in figure 11. The graphic summarizes the points made above while also providing a break down of costs and expenditures. Though broad in scope, these two plans are similar in that they utilize local knowledge and infrastructure to maximize the aid that communities receive.

Initially, many of these proposals may have seemed overly ambitious since hundreds of millions of dollars are expected to go into each project, but Hurricane Harvey clearly had a deep-rooted effect on the not-so-environmentally friendly state of Texas because suddenly, money was no longer a concern. Almost a year after Hurricane Harvey made landfall, an overwhelming 80 percent of voters in Harris County approved the $2.5 billion Harris County Proposition A flood bond, which would raise taxes enough to pay for either Governor Abbot or Augustus Campbell's plan.[59] These projects have the unwavering support of citizens, policy-makers, government officials, and scientists alike, but how much longer will we keep waiting on the slow-moving hand of the federal government? I say this primarily because citizens and local officials have demonstrated an eagerness to move forward with these projects while the U.S. Army Corps of Engineers seem to only be getting in the way.

[58] Arrajj, Shawn. "Houston Area Groups Propose Plan…"
[59] Despart, Zach. "Harris County Voters Pass $2.5 Billion Flood Bond." Houston Chronicle. August 26, 2018. Accessed November 14, 2018. https://www.chron.com/news/houston-texas/houston/article/Harris-County-voters-pass-2-5-billion-flood-bond-13182853.php.

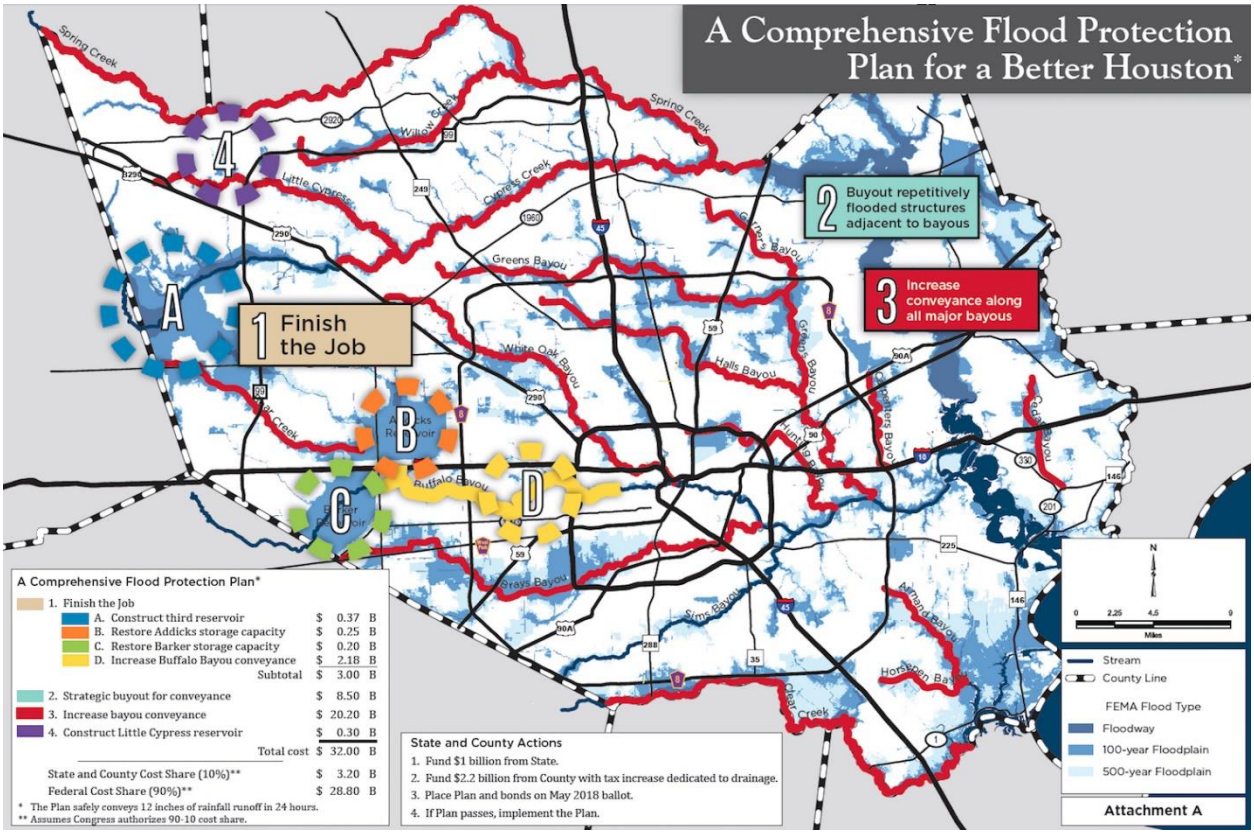

FIGURE 11. THIS GRAPHIC ILLUSTRATES THE COMPREHENSIVE FLOOD PROTECTION PLAN FOR A BETTER HOUSTON PROPOSED BY CAMPBELL. THE AREAS MARKED A, B, C, AND D REPRESENT RESEVOIRS THAT REQUIRE $3 BILLION IN FUNDING TO RESTORE. THE LIGHT-BLUE BOX REPRESENTS A LOCATION THAT SHOULD BE STRATETIGALLY BOUGHTOUT FOR $8.5 BILLION. THE RED LINES THROUGHOUT THE GRAPHIC REPRESENT MAJOR BAYOUS THAT SHOULD BE WORKED ON TO IMPROVE CONVEYANCE FOR $20 BILLION. THE PURPLE CIRCLE IN THE TOP LEFT REPRESENTS THE LITTLE CYPRESS RESEVOIR, WHICH WOULD REQUIRE $0.3 BILLION TO BUILD. / WEST HOUSTON ASSOCIATION

The "Ike Dyke" Proposal

The U.S. Army Corp of Engineers (USACE) is a U.S. federal agency under the Department of Defense that tackles engineering projects in a wide range of public works, such as dam, canal and flood management. USACE has previously come under fire for neglecting environmental degradation and privileging economic and political agendas when making decisions (i.e. most recently the Dakota Access pipeline). Nonetheless, the work performed by USACE is integral in shaping, approving, and carrying out projects across the region and across the country. Their cooperation is needed if we ever hope to move forward with large-scale

infrastructure rehabilitation. Unfortunately, the Gulf Coast is not the only location getting pummeled by natural disasters nor is it the only place in need of research and aid. For this reason, USACE does not expect to publish a detailed proposal of the "Ike Dyke" project until the year 2021, and even then, policy experts expect another 20 to 30 years before the proposal becomes a reality. To further complicate the matter, USACE is proposing a project that solely aims to limit the intensity of storm surges during hurricanes rather than keeping inland communities from experiencing freshwater floods. This shows a clear lack of understanding given that all 68 deaths in Texas during Hurricane Harvey were due to local flooding events rather than storm surges.[60] Still, USACE tackles some of the issues associated with hurricanes at the coastal front rather than within the confines of the city. The proposed project, entitled "Ike Dyke," named after the infamous Hurricane Ike, is grand in scale, cost, and resources, but the project may indeed serve as a precautionary measure. Even though the project may not become a reality any time soon, there is value in analyzing its faults and potential benefits. Perhaps the combined efforts of inland and coastal project will prove far more effective than pursuing just one of the two.

Compared to *Rebuild Texas* and CFPPBH, state officials and federal officials, under the guidance of USACE, proposed 62 miles of "barrier system made up of floodwalls, floodgates and seawall improvements" along Galveston Island (Figure 12). Rather than fortifying and rebuilding inland reservoirs and floodplains, USACE has mainly focused on keeping the "largest coastal petrochemical complex in the country" from harm's way. The fact that $31 billion is needed to complete the "Ike Dyke" project means that the project has also drawn attention and criticism from different research groups. Jim Blackburn, an active Rice University professor in

[60] Lozano, Juan A. "Officials Offer Plan to Protect Texas from Hurricanes." AP News. October 26, 2018. Accessed November 14, 2018. https://www.apnews.com/9dc96e2008bf4b41923c21eae44f30bb.

the reconstruction of Houston, has criticized USACE for basing the "Ike Dyke" off of data collected during Hurricane Ike, which was a category 4 tropical cyclone that hit the Gulf Coast in 2008.[61] This is a major flaw in the project proposal's logic because it essentially creates a structure that can sustain the effects of a hurricane that is in every way incomparable to a hurricane like Harvey. Though any protection from storm surges is beneficial, USACE should include the most recent and relevant data to ensure a project that will withstand not one or two storms, but the collective force of dozens of powerful hurricanes throughout our lifetimes. 2017 alone witnessed Hurricanes Harvey, Irma, and Maria, which were all stronger than Hurricane Ike, so more thought is obviously required if we ever hope to see the "Ike Dyke" project realized in a practical manner. As Blackburn stated, "if all of our eggs are in a $30 billion federal appropriation, that just sounds too risky to me."

[61] Collier, Kiah. "Army Corps, Texas Officials Propose Sweeping Hurricane Protection Plan." The Texas Tribune. October 26, 2018. Accessed November 14, 2018. https://www.texastribune.org/2018/10/26/army-corps-texas-officials-propose-hurricane-protection-plan-houston/.

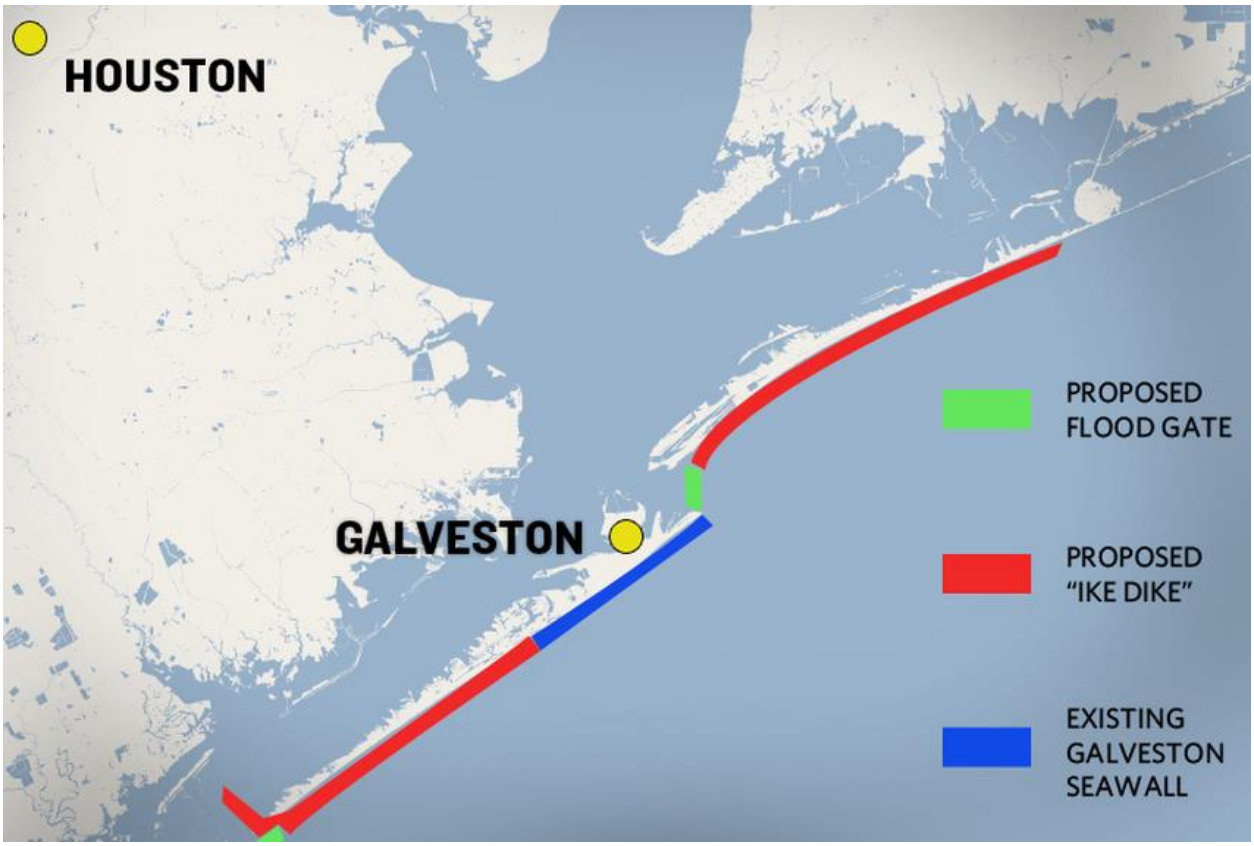

FIGURE 12. THE U.S. ARMY CORPS OF ENGINEERS HAVE PROPOSED A DIKE (IN RED) RUNNING ALONG THE ISLAND CITY OF GALVESTON WITH A FLOOD GATE, MARKED BY GREEN, TO COMBAT STORM SURGES. / TODD WISEMAN

Reiterated throughout this chapter has been the importance of localized efforts in drafting plans and proposals for how to rebuild the city. Local efforts, such as citizen mobilization, university and college research, non-profit work, and the involvement of local officials, have focused on rebuilding and consolidating inland communities because these are the places facing the most infrastructure damage, contamination, and loss of life during hurricanes. Furthermore, the individuals experiencing these problems first-hand are much more knowledgeable on what their immediate needs are. As expected, the USACE prioritizes the protection of the immediate coast because the country as a whole depends on the refineries and factories located in this region. The allocation of aid and the actual projects that will be implemented depend on the funding available and the priorities of the groups providing the resources. At the end of the day,

groups are still mobilizing and rallying support well over a year after Hurricane Harvey occurred, and who knows how much longer it will take for these projects to finally initiate. There are still gaps in our knowledge, but we cannot risk waiting for the next big hurricane to hit before we finally act.

CONCLUSION

Hurricane Harvey will forever remain ingrained in my memory. Not because it was the most devastating hurricane to ever hit the Texas Gulf Coast but because it pressured an entire region to take the threats of climate change and disasters more seriously. A majority of Houstonians were once unaffected by floods and storms altogether, but this has quickly changed. Floods have become more frequent in Houston in the last two decades as the city has welcomed nearly half a million more people. As the city has grown and developed, concrete surfaces have altered the region's watersheds by increasing the amount of rain water that enters floodplains. Furthermore, the industrialization of the economy and subsequent deforestation of the coast has weakened sand banks and exacerbated the effects of hurricanes. If Houston continues to grow, then more dangers are expected to surface as more people are placed in the trajectory of future hurricanes.

Throughout this thesis, I have laid out several factors that contribute to the overall intensity of hurricanes within a region. First, I linked human consumption of nonrenewable resources to climate change. This was done to remind the reader of the complex ways that humans have interacted with their environments and to show how the environment has in turn responded to these interactions. My main purpose in providing a scientific background on hurricane formation and hurricane ecology was to convince the reader that humans have played an active role in how powerful hurricanes have become under global warming. I described the transition of Houston from a plantation-based economy to one heavily reliant on oil to contextualize the history of African-American settlement throughout the city. I argue that white settlers chose to create suburbs in higher elevations, such as the Houston Heights, Montrose, and West University Place, because they were distant and elevated from floodplains. In settling these

areas, white settlers ensured that poor and black folk would be unable to afford and inhabit these locations, which was evident in the unfair housing practices described in chapter 2. Chapter 2 framed the discussion of disasters around class and race as it showed that the poorest neighborhoods in Houston were located directly on floodplains where the wealthiest neighborhoods were located throughout west-central Houston, which is the least affected by floodplains. Chapter 3 furthered this discussion by pinpointing the flaws associated with state and federal aid following a disaster. Essentially, the aid provided by FEMA after any disaster is heavily limited by the sheer number of people that require it. To make matters worse, private insurance companies and the National Flood Insurance Program charge premiums that are simply out of reach for low-income households, which also have the highest flood risks. Furthermore, I condemn Houston's lack of affordable housing as being one of the main reasons behind the sudden spike in homelessness across the city. I conclude by looking towards local, state, and federal officials as they draft and propose flood mitigation projects. Through my analysis of three separate proposals, I conclude that they each have potential to limit the intensity and frequency of flooding, but they still require much more thought before being realized.

Ultimately, disasters like Hurricane Harvey are complex phenomena that reverberate throughout an entire region. They are inherently complicated, and they increasingly seem to behave in ways we have never seen before. This is where its worth noting that the world we live in now is not the same world that the generations before us experienced. Environmental degradation has only become more and more apparent, and every day, we seem to be nearing a definitive crash in our society. If anything, I hope this thesis illuminates the discrepancies between those causing environmental degradation and those directly facing it. It may be true that climate change is indiscriminate and all-encompassing, but to say that we all suffer equally when

disasters strike is false. Only by acknowledging these inequalities can we truly be of service to the affected communities. If nothing else, Hurricane Harvey showed us just how unnatural these disasters can truly be.

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